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EFFECTS OF STORAGE TEMPERATURES
ON
QUALITY OF COTTONSEED SALAD OIL

Marketing Research Report No. 861

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PREFACE

This report is part of a study for the determination of the effects of storage temperatures on keeping quality of cottonseed and soybean salad oils in sealed 1-gallon containers.

Marketing Research Report No. 862, entitled "Effects of Storage Temperatures on Quality of Soybean Salad Oil," is another report on this work.

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EFFECTS OF STORAGE TEMPERATURES ON QUALITY OF COTTONSEED SALAD OIL

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SUMMARY AND CONCLUSIONS

Three different lots of cottonseed salad oils, packaged in sealed 1-gallon metal containers, were stored for periods up to 2 years at specified temperatures ranging from 55° F. to 110° F.

A taste panel of housewives evaluated the oils by comparing them with similar oils that had been held frozen at 0° F. during the 2-year period.

The heated stored oils showed small decreases in quality as measured by a decrease in flavor scores during the 2 years. Heating the oils during storage caused the bland flavor to decrease significantly. Varying increases were shown in grassy, tallowy, metallic, musty, painty, beany, and buttery flavors.

The oils that had been removed from both the heated and the refrigerated storage were exposed to air during 4 days of treatment at 140° F., then a second evaluation of flavor was made.

The flavor scores indicated an improvement in quality of the oils after they were given the 4-day heat treatment. More of the samples were judged to have bland flavor and fewer to have grassy, tallowy, metallic, musty, painty, beany, and buttery flavors.

These results suggest that storage of the oils at higher temperatures caused some decrease in quality and some development of off flavors in the oils. However, the 4-day heat treatment with exposure to air eliminated the off flavors and restored the oils to about their original quality.

INTRODUCTION

Vegetable salad oils packaged in sealed 1-gallon metal cans containing cottonseed or soybean oil are generally used domestically within a short time after manufacture. However, when purchased by the Commodity Credit Corporation, these oils may be held in storage for several months before shipment overseas. To insure maintenance of quality, the Government agency may use refrigerated storage. Normally these oils are held at room temperature before purchase domestically or by the Government.

Industry sources have estimated that salad oils made from cottonseed or soybeans and containing no synthetic antioxidants should change very little in quality for periods up to a year or more, if held under reasonable temperatures. This is particularly true for cottonseed salad oils. However, salad oils purchased by the Government may be subjected to much higher temperatures during shipment and in foreign ports.

No previous data were available comparing cottonseed or soybean salad oils in sealed containers for periods of time under controlled temperatures with similar oils in refrigerated storage, with or without added synthetic antioxidants.

OBJECTIVES

The primary objectives of this study were to compare the flavor of cottonseed salad oils in sealed containers after dry storage and after refrigerated storage, and then, after a heat treatment with the cans open, to compare the flavor of the same oils again.

Other objectives were:

(1) To determine the storage temperature and time required for the oils to develop a difference in flavor that could be noticed by the average consumer either at the end of the storage period or after the heat treatment during which the cans were open.

(2) To determine any relationships between the quality of the oils before and after storage; and after the further heat treatment.

(3) To ascertain the relationship between flavor scores and flavor adjectives as used by the taste panel.

METHODS

Procurement and Storage of Oil

Among the vendors who have been approved by the United States Government, 10 have sold cottonseed salad oil for export packaged in 1-gallon metal containers during recent years. These vendors have complied with Federal specifications.[1] Three of these vendors made oils available for this study, one from the east coast, one from the west coast, and one from the southern area of the country. From each source, thirty-six 1-gallon containers of oil were obtained. Each lot of oil (hereinafter designated as source 1, source 2, or source 3) was assumed to have been canned from the same batch of oil processed at the refinery, which meant that it had the same source of cottonseed and went through the processing stages of extraction, refining, winterization, and deodorization of the oil at the same time.

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[1] FEDERAL SPECIFICATIONS FOR SALAD OIL AS APPROVED BY THE COMMISSIONER, FEDERAL SUPPLY SERVICE, GENERAL SERVICES ADMINISTRATION, FOR USE OF ALL FEDERAL AGENCIES. JJJ–S–30 (with Amendment 2). May 4, 1964.

Each lot was divided so that 12 cans were put into storage at 0° F. and held frozen as controls for comparison with the same oils stored at the higher temperatures. The other 24 cans were put into constant-temperature cabinets, four cans each at 55°, 70°, 80°, 90°, 100°, and 110° F. until ready for taste panel tests. Cans held at 0° F. (controls) were removed from refrigeration as needed for panel evaluations.

Flavor Evaluation

The flavor panel or taste panel, hereinafter called the "panel," followed the general procedures used at the Northern Utilization Research and Development Division, ARS, at Peoria, Ill.,[2] except for the qualifications of the panelists conducting the evaluations. The Peoria laboratory panel was made up of personnel who had been highly trained in the evaluation of salad oils, and the scores given to the oils by the individual panelists and the average for all the panelists would show less variation than would be expected from the panel used in this study.

The preliminary training of those chosen for this panel, mostly housewives, did not require that they be experts in distinguishing small differences between the oils. However, they were expected to be able to distinguish large differences in flavor between oils prepared especially for choosing panelists. Most of those used in the panel did have some previous experience in evaluating quality differences in and preferences for frozen fruits, vegetables, juices, sauces, etc., but not in evaluating salad oils.

At the end of each 6-month period, cans of the oils, after being removed from storage and cooled to 0° F., were sent to the panel for evaluation along with the control cans which had been held at 0° F. All of the oils were warmed to 98° F. immediately before the evaluations, and were refrozen at 0° F., after samples had been taken for the day's evaluations.

The oils were coded before presentation to the panel to distinguish the source number, the control for each source, and cans that were stored at higher temperatures. The code did not disclose the temperature of storage. The panel supervisor filled in separate reports for the codes used in the particular series evaluated. The panel members did not know which one of the samples was the control, nor did they know they were evaluating the same oils under the same conditions several times when these oils were compared with the six oils stored at different temperatures. The oils from one source were not compared with oils from the other two sources, either as controls or at higher storage temperatures. No definitions of the descriptive adjectives used on the report forms were given to the panelists before or during the evaluations.

There were 20 panelists on each day. Three "sittings" were made at half-hour intervals. At each sitting of the panel in the 6-, 12-, and 18-month evaluations, four samples were tested, one of which was the control and three of which were high-temperature-stored oils from the same source (Report 1, Appendix). Two sittings were required to judge the six high-temperature-stored oils from each source.

In each sitting, at the end of 24 months, two of the high-temperature-stored oils were compared with the control (Report 3, Appendix). This required two sittings of the panel for each of the three sources.

Post-Storage Heat Treatment

In previous taste panel work by Moser and coworkers, it had been found that heating both the controls and the oils to be evaluated, while they were exposed to air, accentuated the flavor of the oils.[2] This treatment may also remove some volatiles formed during the storage period. Therefore, after the first evaluation in this study, all samples of these oils were heated for 4 days at 140° F. (60° C.) in glass containers loosely stoppered with Pyrex wool.[3] After this 4-day heat treatment of all storage oils and controls, they were subjected to evaluation by the taste panel again.

At the end of the 6-, 12-, and 18-month storage periods, each of the six high-temperature-stored oils that had received a 4-day heat treatment was compared separately with the 4-day-heat-treated control. Three evaluations were recorded for each of the 2 days' sittings for each of the three sources (Report 2, Appendix). At the end of 24 months, the oils previously stored at higher temperatures were compared to the control in groups of two (Report 4, Appendix). Results were recorded as differences in flavor scores, as with the previous evaluations.

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[2] MOSER, HELEN A., H. J. DUTTON, C. D. EVANS, and J. C. COWAN. CONDUCTING A TASTE PANEL FOR THE EVALUATION OF EDIBLE OILS. Food Technol. 4: 105–109. 1950.

[3] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

FLAVOR SCORES IMMEDIATELY AFTER STORAGE

Variation in Scoring

It was expected that there would be rather large variations in the flavor scores for each of the evaluations by the panel, not only between individual panelists for the same oil at the same sitting and on the same day, but by the same panelists at different sittings as well. This can be shown by measuring the variations in the flavor scores for the oils held frozen at 0° F. (the controls). There is no reason to expect any changes in the flavor of the samples of oil held far below its freezing point. Accordingly, the best estimate of the flavor score would be an average of the many scores given to each of the control oils from the three sources. These data are shown in table 1.

No relationship is shown between the average score and the length of time the control sample was in storage; the flavor score did not change during storage of the oils at 0° F.

There was a highly significant relationship, however, between the average flavor score and the standard deviation. As the average flavor score decreased, the variation, as measured by the standard deviation, increased.[4] As an example, when the formula is used for a flavor score of 9.35, the standard deviation would be ±0.9913 and for a flavor score of 7.40, the standard deviation would be ±1.8392.

Accordingly, using average flavor scores for each sitting of the panel of 20 panelists, for the control and the oil in heated storage from 55° to 110° F., the change of flavor with time of storage could not be determined with any degree of accuracy. A better estimate of change in flavor could be made by determining the difference between flavor scores of the control oil and of the heated stored oil at each evaluation, than by using average flavor scores for the control and the heated stored oil for the 20 panelists at each sitting. Each comparison of the control sample with the heated stored oil constituted a single observation. For oil from each source at a different storage temperature, there were 20 different individual comparisons with the control oil. Four different storage periods gave 80 observations on each of the oils at each storage temperature. These results were used in linear correlations as follows.

Changes After Storage

Figures 1, 2, and 3 show the linear correlations for these differences in flavor scores of the oil from each source at each of the six temperatures of storage. The formulas for the regression lines are shown in table 2.

For the oils from source 1, as shown in figure 1, the differences in the flavor scores did not appear to increase progressively with temperature of storage. For four of the temperatures, the flavor score decreases were a little greater with time of storage, but for the oil stored at 70° F., the difference seemed to be smaller as storage time increased. The oil stored at 100° F. had lower flavor scores than the refrigerated oils for the first year of storage, but the differences decreased until the flavor seemed to be improved by the heated storage.

The differences in the flavor scores for the oils from source 2 increased with time for all six temperatures of storage (fig. 2). However, this increase in differences with time did not seem related to the temperature of storage.

Table 1.—*Variation in flavor scores of cottonseed salad oils stored at 0° F.*

[Each average and standard deviation was calculated from the flavor scores of the 20 panelists at one sitting of the panel.]

Months in storage	Source 1		Source 2		Source 3	
	Average score	Standard deviation	Average score	Standard deviation	Average score	Standard deviation
6	9.05	±1.0990	6.80	±1.8876	8.80	±1.4364
6	8.70	±1.5252	6.85	±1.9554	9.20	±1.0052
12	8.75	±1.4096	7.60	±2.0622	9.35	±0.9882
12	8.45	±1.3945	8.20	±1.3219	8.45	±1.0090
18	8.30	±1.3018	8.15	±1.1367	8.05	±1.8489
18	8.10	±1.4832	8.00	±1.6859	7.40	±2.1126
24	8.95	±1.0501	8.60	±1.5009	8.15	±2.0072
24	8.95	±1.0990	8.35	±0.9333	8.40	±1.2312
Total	8.66	±1.3177	7.82	±1.6930	8.54	±1.6171

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[4] The formula for all the three sources of the oil is: $Y = 5.0566 - 0.4348X$, where X=the flavor score and Y=the standard deviation. Also, $r = -0.7688$, $N = 24$, and $S_{YX} = \pm 0.2502$.

TABLE 2.—*Correlation data for differences of flavor scores of 3 cottonseed salad oils after storage at 6 temperatures from flavor scores of the same oils after storage at 0° F.*

Storage temperature and oil source	Formula	N[1]	r[2]	S_{Y_X}[3]
Oil stored at 55° F.:				
Source 1	Y=+0.0250—0.0725X	80	—0.2781	±1.6905
Source 2	Y=+2.9750—0.1983X	80	—0.5957	±1.8050
Source 3	Y=—0.1750—0.0308X	80	—0.1479	±1.3920
All sources	Y=+0.5825—0.0766X	240	—0.3136	±1.7864
Oil stored at 70° F.:				
Source 1	Y=—0.5500+0.0375X	80	+0.1429	±2.2262
Source 2	Y=+1.6750—0.1600X	80	—0.4577	±2.0982
Source 3	Y=—0.0367X	80	—0.1566	±1.5709
All sources	Y=—0.1895—0.0404X	240	—0.1603	±1.9165
Oil stored at 80° F.:				
Source 1	Y=+0.5500—0.0750X	80	—0.2132	±2.3202
Source 2	Y=+0.4000—0.1000X	80	—0.2500	±2.2842
Source 3	Y=—0.1500—0.0350X	80	—0.1523	±1.5282
All sources	Y=—0.3417—0.0533X	240	—0.1848	±2.1725
Oil stored at 90° F.:				
Source 1	Y=+1.1000—0.0200X	80	—0.0574	±2.3486
Source 2	Y=+0.6500—0.0775X	80	—0.2583	±2.0824
Source 3	Y=+0.8750—0.0075X	80	—0.0238	±2.1252
All sources	Y=—1.1000—0.0267X	240	—0.0938	±2.1797
Oil stored at 100° F.:				
Source 1	Y=—0.6000+0.0378X	60	+0.1081	±2.0150
Source 2	Y=+1.2865—0.1776X	60	—0.3830	±2.2023
Source 3	Y=—1.9846+0.0910X	60	+0.2702	±1.6675
All sources	Y=+0.7103—0.0162X	180	—0.0418	±1.9867
Oil stored at 110° F.:				
Source 1	Y=—1.4111—0.0489X	60	—0.1191	±2.2854
Source 2	Y=—1.1000—0.0200X	40	—0.0460	±2.2902
Source 3	Y=—1.1474—0.01800X	60	—0.0046	±2.1657
All sources	Y=—1.3013—0.0288X	160	—0.0720	±2.2229

[1] Number of observations. Oils stored at 55°, 70°, 80°, and 90° F. were evaluated after 6, 12, 18, and 24 months. Oils stored at 100° F. were evaluated after 6, 9, and 18 months. Oils stored at 110° F. were evaluated after 5, 8, and 18 months, except that oil from source 2 was not evaluated at 5 months.

[2] Correlation coefficient. At the 5-percent confidence limit, r=0.254 when N=60, and r=0.220 when N=80. At the 1-percent confidence limit, r=0.302 when N=60, and r=0.286 when N=80.

[3] Standard error of estimate.

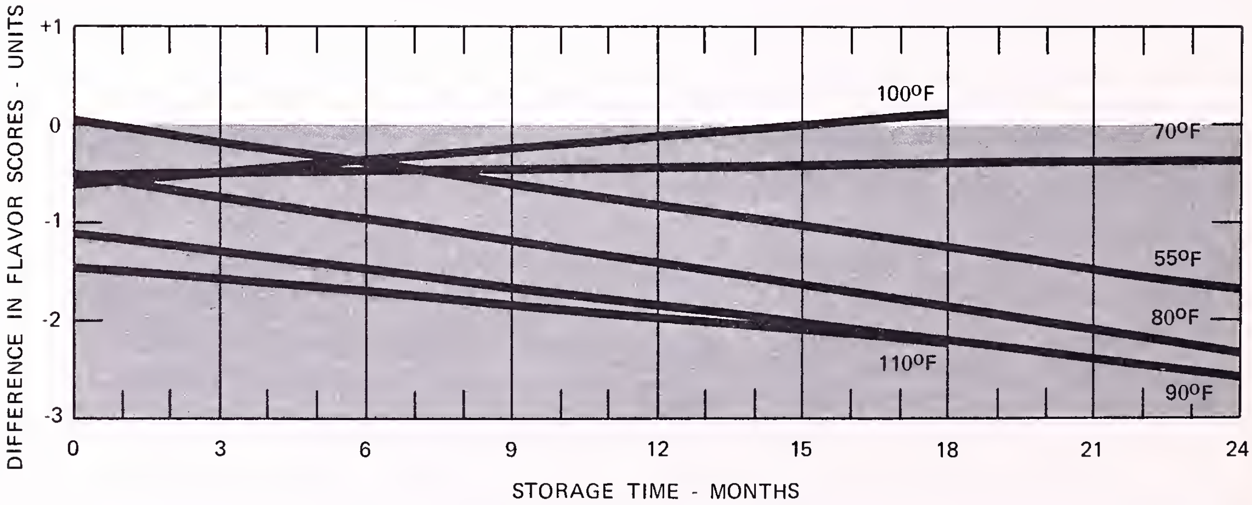

FIGURE 1.—Cottonseed salad oil from source 1: Differences in flavor scores between oil stored at 6 temperatures and oil stored at 0° F.

In figure 3, showing the changes in differences for the oils from source 3, all of the storage temperatures except one showed an increase in the difference in flavor scores as time of storage increased. At 100° F., the flavor score at the end of 24 months seemed to be higher than that when the oil was originally stored.

The formulas and other correlation data are shown in table 2 for the six storage temperatures for oils from the three sources. Most of the correlation coefficients (r) were statistically significant at the 5-percent confidence level. The regression coefficients did not differ significantly for the three sources of oil at each of the temperatures. Accordingly, data from the three sources were grouped to give a formula for "all sources," shown in figure 4, for each of the six temperatures of storage. The six formulas indicated an improved

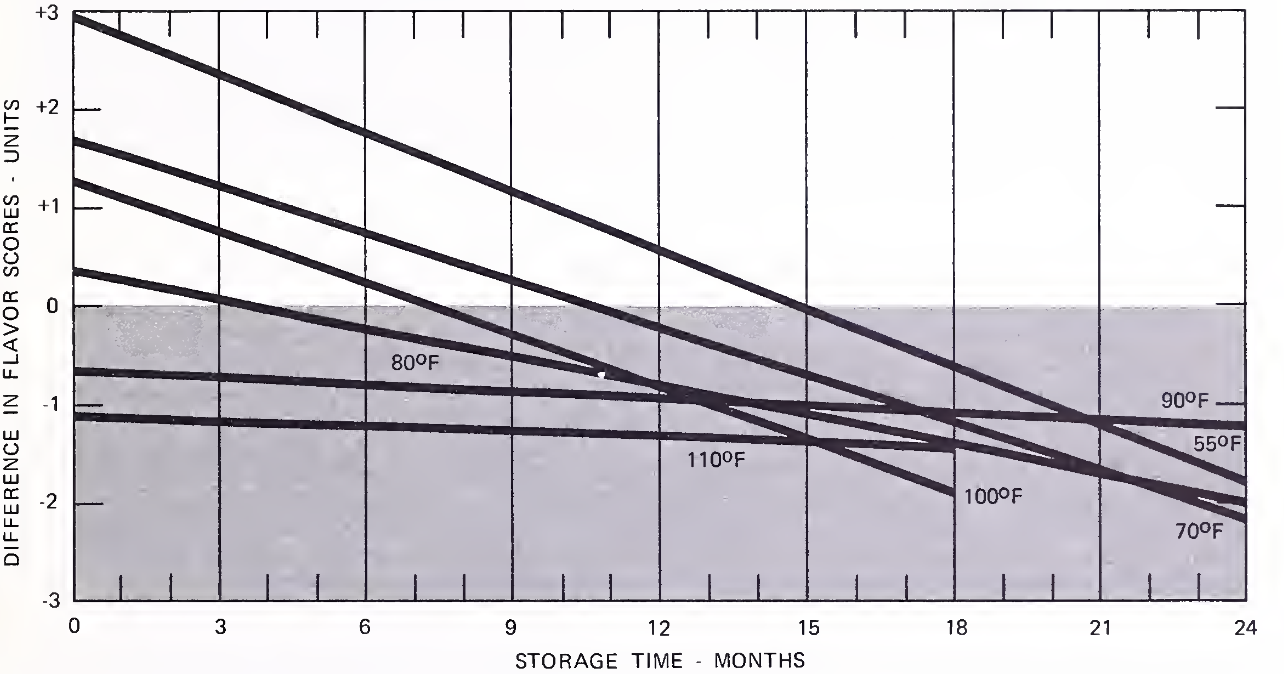

Figure 2.—Cottonseed salad oil from source 2: Differences in flavor scores between oil stored at 6 temperatures and oil stored at 0° F.

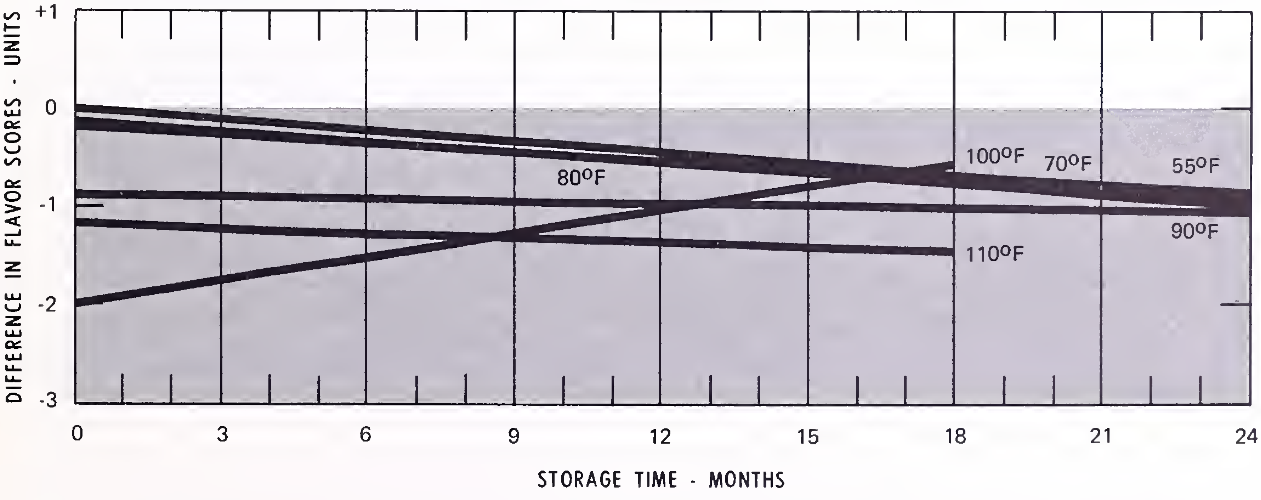

Figure 3.—Cottonseed salad oil from source 3: Differences in flavor scores between oil stored at 6 temperatures and oil stored at 0° F.

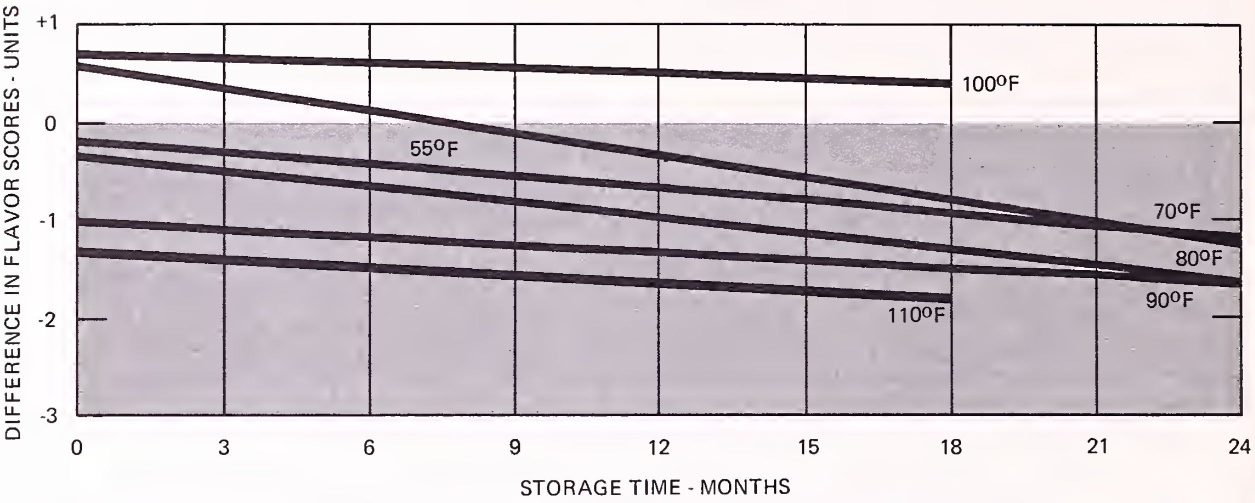

FIGURE 4.—Cottonseed salad oils from all sources: Average differences in flavor scores between oils stored at 6 temperatures and oil stored at 0° F.

significance of the coefficients of correlation, and it was evident that there were smaller differences in the regression coefficients than there were when the three sources were considered separately.

In figure 4 the oils seemed to decrease slightly in quality with time, though not consistently by temperature of storage. The decreases were slight, and the variation in flavor scores by the panel was great enough that the apparent decreases with time were assumed not to be important. It was estimated from this data that the quality of the three cottonseed oils had not been seriously affected by either time or temperature of storage during the 2-year period.

FLAVOR SCORES AFTER STORAGE PLUS HEAT TREATMENT

Variation in Scoring

It was expected that the controls, after the heat treatment, would vary in flavor scores to about the same extent as they did before the treatment. It was also expected that the additional heat treatment would lower the flavor scores of the oil. Since the controls after the 4-day heat treatment were compared with the previously heat-stored oils more often, a greater number of average scores were available for the overall average scores. These data are shown in table 3.

Changes After Heat Treatment

When the flavor scores for the control oils after the heat treatment were compared with scores for the same oils before the treatment, the scores were lower for the heat-treated oils. Oil from source 1 had decreased in average flavor score from 8.66 to 8.00, a reduction of 0.66 units, oil from source 2 from 7.82 to 6.68, or 1.14 units, and oil from source 3 from 8.54 to 7.96, or 0.58 units. Also the standard deviations in flavor score increased for each of the three oils. It was expected that the lower flavor scores would show greater standard deviations, as was true of the scores before the 4-day heat treatment of the oils.

Within the data for heat-treated oils, the increase in the standard deviation as the flavor score decreased was highly significant.[5] However, the rate of increase was less than that for oils before the 4-day heat treatment.

Linear correlations were calculated in the same manner as before. Both the controls and the oils from heated storage decreased in flavor score for all three sources of oil. However, since the difference in flavor scores was the principal objective of this study, the following data relationships concern these differences, whether plus or minus. Figures 5, 6, and 7 show data for oil from the three sources, and figure 8 for oil from all sources. Formulas used are shown in table 4.

Figure 5 shows that source 1 oil from five of the six storage temperatures increased the difference of flavor scores after the 4-day heat treatment. The heat treatment eliminated some of the off flavors which could have developed in the oil in the sealed cans during previous storage. However, these

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[5] The formula for all three sources of the oils is: $Y = 3.3032 - 0.2228X$, where X = the flavor score and Y = the standard deviation, also $r = -0.6860$, $N = 60$, and $S_{Y_X} = \pm 0.2189$.

TABLE 3.—*Variation in flavor scores of 3 cottonseed salad oils stored at 0° F. and heat treated for 4 days at 140° F.*

[Each average and standard deviation was calculated from the flavor scores of the 20 panelists at one sitting of the panel.]

Months in storage	Source 1		Source 2		Source 3	
	Average score	Standard deviation	Average score	Standard deviation	Average score	Standard deviation
6	7. 95	±1. 6694	5. 75	±1. 9702	8. 95	±1. 0966
6	7. 45	±1. 6694	5. 65	±2. 4979	8. 60	±1. 2312
6	8. 00	±1. 4142	5. 90	±1. 7317	8. 15	±1. 5313
6	8. 40	±1. 4290	5. 70	±1. 9762	8. 60	±1. 1877
6	8. 95	±1. 6376	6. 20	±1. 5079	8. 80	±1. 2814
6	8. 20	±1. 7351	5. 95	±2. 0384	8. 90	±1. 1653
12	7. 90	±1. 5861	8. 35	±1. 4905	8. 95	±1. 1459
12	8. 00	±1. 4868	8. 25	±1. 4464	8. 80	±1. 3611
12	8. 65	±1. 1821	7. 25	±1. 9160	8. 80	±1. 3992
12	7. 80	±1. 6092	7. 55	±1. 9595	8. 70	±1. 2183
12	8. 05	±1. 1910	7. 60	±2. 2100	8. 35	±1. 3870
12	8. 35	±1. 2680	7. 55	±1. 4681	9. 10	±1. 1653
18	8. 20	±1. 4726	6. 10	±1. 8610	7. 55	±1. 7911
18	7. 45	±1. 8202	6. 10	±1. 7442	6. 55	±2. 5849
18	8. 85	±1. 2258	5. 50	±1. 4327	6. 35	±1. 9808
18	7. 50	±1. 7014	6. 35	±2. 0844	6. 80	±1. 9628
18	7. 95	±1. 3169	6. 35	±1. 3485	6. 25	±2. 1734
18	8. 15	±1. 5985	6. 40	±1. 3917	6. 35	±1. 8432
24	7. 65	±1. 5985	7. 10	±1. 9440	7. 20	±2. 0157
24	7. 50	±1. 7321	7. 15	±1. 6631	8. 10	±1. 5861
Total	8. 00	±1. 5656	6. 88	±1. 9536	7. 96	±1. 8573

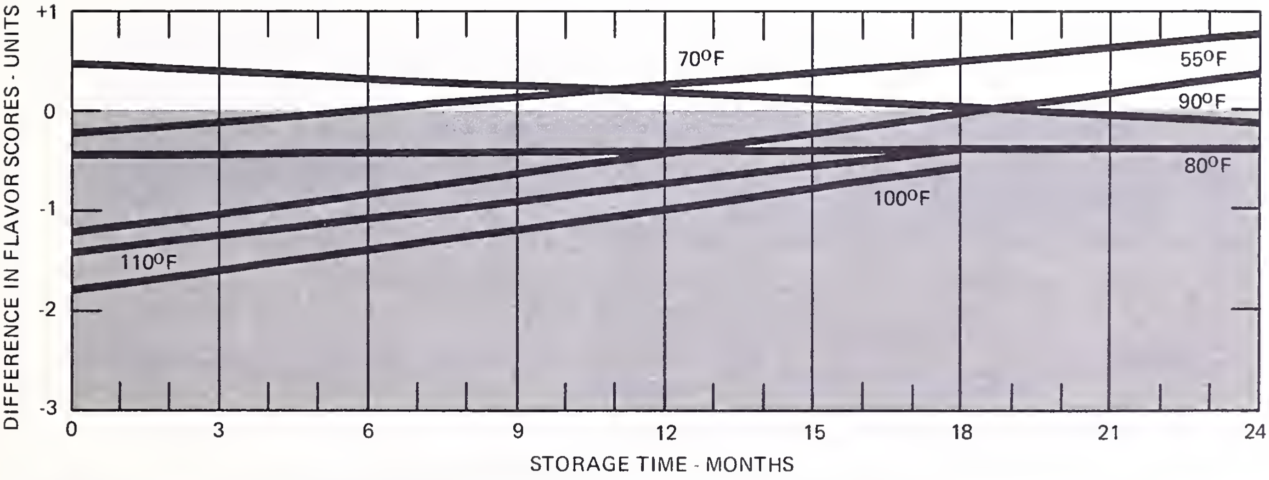

FIGURE 5.—Cottonseed salad oil from source 1: Differences in flavor scores between oil stored at 6 temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

changes were rather small and in most cases not statistically significant.

Oils from source 2, however, after the 4-day heat treatment, showed some minor increases in differences with time and temperature of previous storage (fig. 6). This indicated some minor decrease in flavor score, but in only about three instances were the correlations significant.

Figure 7 shows that the two oils from source 3 previously stored at the highest temperatures improved in flavor score from the 4-day heat treatment. These two correlations were highly significant (table 4). The oils from the four lower storage temperatures, however, decreased in flavor score.

No significant differences were shown between

TABLE 4.—*Correlation data for differences of flavor scores of 3 cottonseed salad oils after storage at 6 temperatures from flavor scores of the same oils after storage at 0° F., after a 4-day heat treatment of all oils at 140°F.*

Storage temperature and oil source	Formula	N[1]	r[2]	S_{Y_X}[3]
Oil stored at 55° F.:				
Source 1	$Y=-1.1750+0.0600X$	80	+0.2631	±1.4787
Source 2	$Y=+0.4500-0.0250X$	80	−0.1003	±1.6792
Source 3	$Y=+0.1500-0.0083X$	80	−0.0381	±1.4743
All sources	$Y=-0.2373+0.0080X$	240	+0.0395	±1.5669
Oil stored at 70° F.:				
Source 1	$Y=+0.2000-0.0392X$	80	+0.1343	±1.9535
Source 2	$Y=+1.2250-0.0767X$	80	−0.2823	±1.7588
Source 3	$Y=+0.3500-0.0425X$	80	−0.2046	±1.3728
All sources	$Y=+0.3631-0.0203X$	240	−0.0886	±1.7584
Oil stored at 80° F.:				
Source 1	$Y=-0.4250+0.0017X$	80	+0.0069	±1.6234
Source 2	$Y=+0.8250-0.0608X$	80	−0.2236	±1.7898
Source 3	$Y=+0.7250-0.0575X$	80	−0.1987	±1.9146
All sources	$Y=+0.2361-0.0296X$	240	−0.1263	±1.7928
Oil stored at 90° F.:				
Source 1	$Y=+0.4750-0.0258X$	80	−0.0916	±1.8960
Source 2	$Y=+0.0750-0.0358X$	80	−0.1229	±1.9528
Source 3	$Y=+0.2250-0.0091X$	80	−0.0322	±1.9228
All sources	$Y=+0.1740-0.0180X$	240	−0.0714	±1.9365
Oil stored at 100° F.:				
Source 1	$Y=-1.7904+0.0673X$	60	+0.1876	±1.8123
Source 2	$Y=+0.6192-0.0987X$	60	−0.2793	±1.7501
Source 3	$Y=-0.4481+0.0801X$	60	+0.2904	±1.3574
All sources	$Y=-0.05632+0.0144X$	180	+0.0521	±1.8000
Oil stored at 110° F.:				
Source 1	$Y=-1.3592+0.0477X$	60	+0.1543	±1.7109
Source 2	$Y=+0.0100-0.0200X$	40	−0.0781	±1.2757
Source 3	$Y=+1.0371+0.1004X$	60	+0.3040	±1.7628
All sources	$Y=-0.9889+0.0547X$	160	+0.1773	±1.6884

[1] Number of observations. Oils stored at 55°, 70°, 80°, and 90° F. were evaluated after 6, 12, 18, and 24 months. Oils stored at 100° F. were evaluated after 6, 9, and 18 months. Oils stored at 110° F. were evaluated after 5, 8, and 18 months, except that oil from source 2 was not evaluated at 5 months.

[2] Correlation coefficient. At the 5-percent confidence limit, r=+0.254 when N=60, and r=+0.220 when N=80. At the 1-percent confidence limit, r=+0.302 when N=60, and r=+0.286 when N=80.

[3] Standard error of estimate.

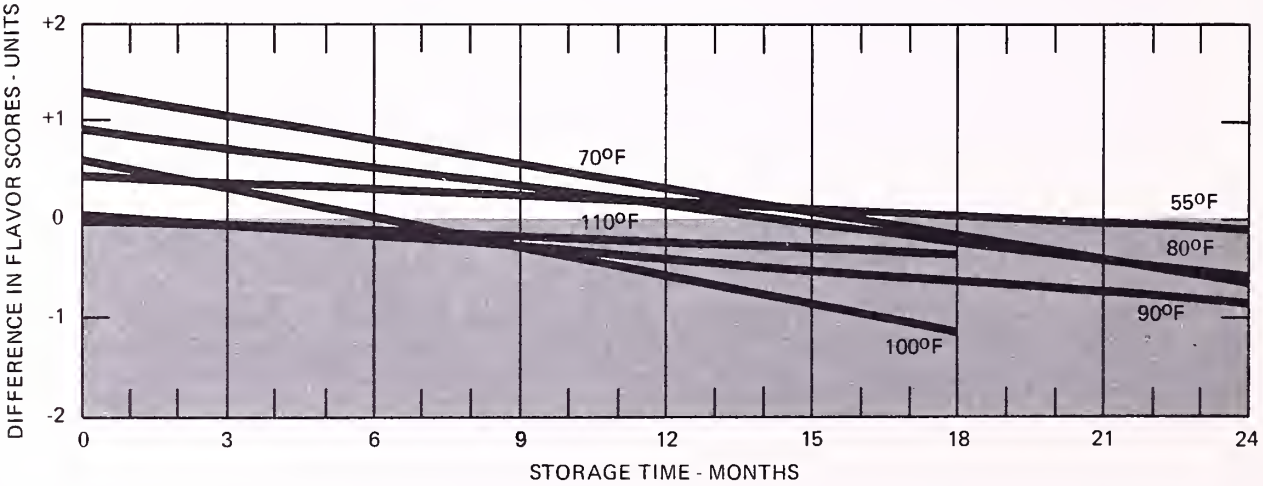

FIGURE 6.—Cottonseed salad oil from source 2: Differences in flavor scores between oil stored at 6 temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

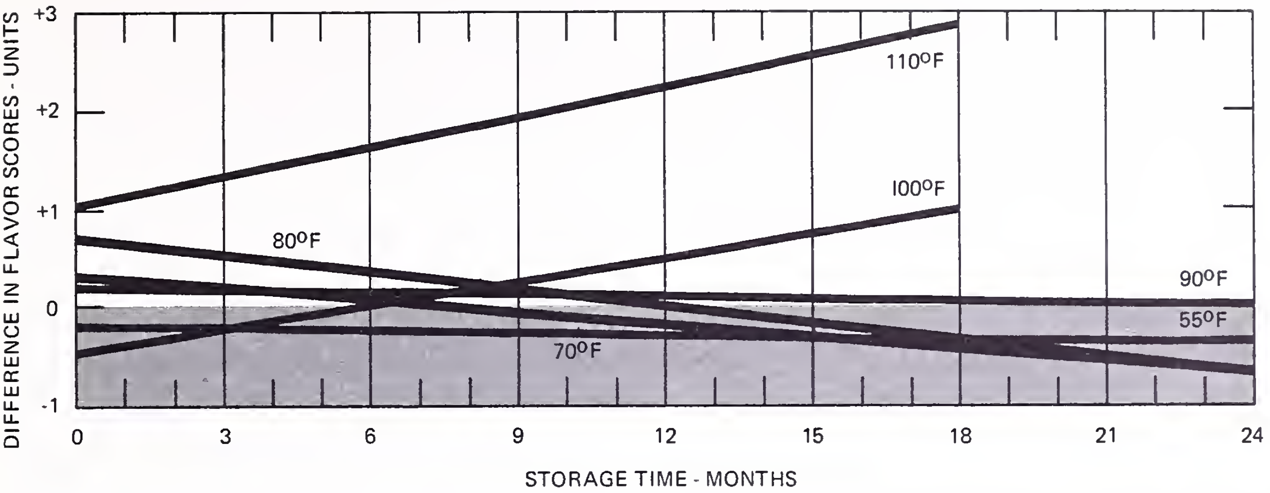

FIGURE 7.—Cottonseed salad oil from source 3: Differences in flavor scores between oil stored at 6 temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

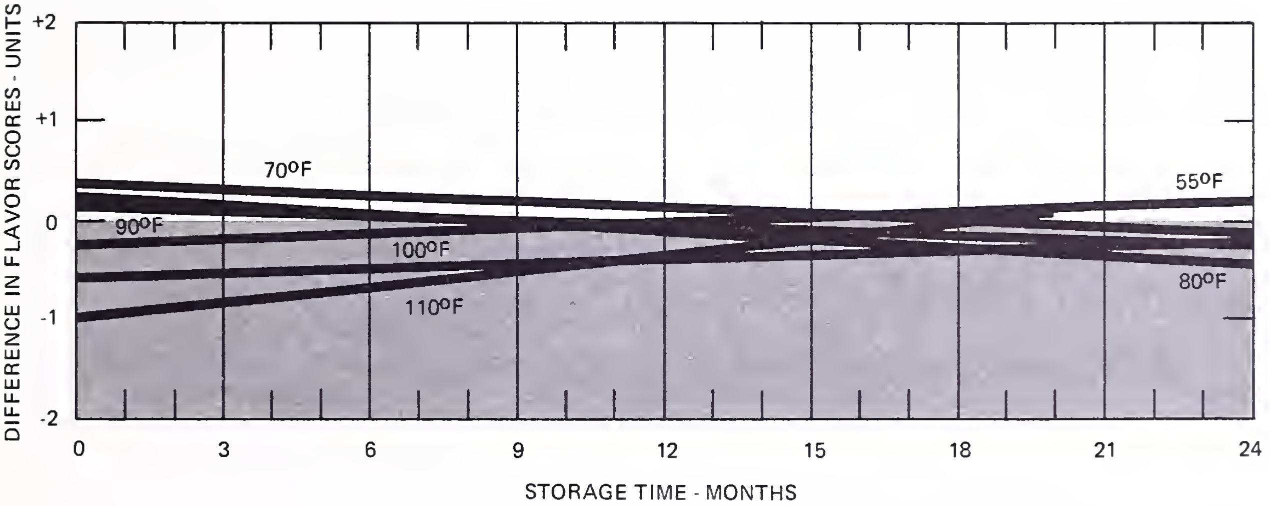

FIGURE 8.—Cottonseed salad oils from all sources: Average differences in flavor scores between oils stored at 6 temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

the regression coefficients for the three sources of oil at any of the six temperatures of storage. Accordingly, these data were grouped and their correlations shown in figure 8. There were minor changes in the flavor scores for the oils from heated storage.

Comparison of figures 4 and 8 shows that the rate at which the regressions decreased during the 2-year storage was much less in oils that had received the 4-day heat treatment than it was in oils that had not received the heat treatment.

For the entire group of oils stored at six different temperatures, the change of differences in flavor score at the end of the 24 months' storage ranged from +0.32 to −2.00 before the 4-day heat treatment and from +0.32 to −0.42 after it. Although, strictly speaking, there cannot be a difference between scores of the oils at the various temperatures of storage and that of their controls at zero months, normal variation gave an average of −0.2566 change of differences for the group without heat treatment and −0.1694 for the group of oils after the 4-day heat treatment. These two values were not significantly different from zero or from each other.

The decrease in quality, as shown by flavor scores, of the oils in heated storage in sealed containers from that in refrigerated storage, although not considered important, appears to have been eliminated by further heat treatment when the oil was exposed to air. The causes of the off flavors may have been volatilized during the 4 days at a temperature of 140° F.

FLAVOR ADJECTIVES USED

Quality vs. Preference

In standards now used by the edible oil industry, bland salad oils are considered to be of the highest quality and are therefore scored highest by well-trained taste panels. Very small differences in flavor are noted.

Even though our housewife panel may have been unable to distinguish very small differences in blandness, they were able to determine their *preference* for certain oils. It is entirely possible that the housewife panel was indicating a preference for an oil not quite as bland as the fresh oils.

Scoring by Descriptions

It was expected that any change of flavor score during either or both of the 2-year storage and the further 4-day heat treatment would relate in some measure to the descriptive adjectives used in the panel evaluations. Accordingly, the 12 descriptive terms used at the evaluations, along with numerical scores for comparing flavor of the control with those of the heated oils over the 2-year period, could indicate the nature of the flavors causing these quality changes. Also, the further heat treatment in the presence of air could cause different flavors of the oils. In this latter treatment, the control was compared with the heated 2-year-stored oils after the control had also been subjected to the same 4-day heat treatment.

Each individual tasting made by each of the panelists on each of the oils was tabulated and totaled for each flavor description and adjusted on a percentage basis. The summary for the evaluations made when the oil was taken from storage *before* the 4-day 140° F. heat treatment is shown in table 5. A summary of the data *after* the 4-day 140° F. heat treatment is shown in table 6.

As shown in table 5 for 0° F., for source 1 oil at 6 months, 53 percent of the panelists described the flavor as bland, 41 percent as buttery, 2 percent as sweet, and 4 percent as tallowy. Table 6 shows that after the 4-day heat treatment, 31 percent of the panelists judged the same oil bland; 40 percent buttery; 9 percent beany; 2 percent sweet; 1 percent each sour, grassy, painty, and musty; 5 percent each metallic and tallowy; and 4 percent rancid.

The flavor descriptions of the control oils were compared with those of the oils in heated storage over the 2-year period, before and after the 4-day 140° F. heat treatment. The differences were calculated as done previously with flavor scores. Table 5 shows a value of −8 and table 6 a value of −2 for oil from source 1 stored at 55° F. for 6 months.

In tables 5 and 6 there were 65 observations each for these differences in flavor descriptions before and after the 4-day heat treatment. Linear correlations to relate these data to time in storage are shown in table 7.

Changes After Storage and After Heat Treatment

Figures 9 through 11 show the changes in flavor descriptions based on the data in table 7. As the descriptions "sweet," "sour," and "bitter" were seldom used by the panel, no calculations were made from these data.

Considerable variation was expected in use of the flavor descriptions by the panel, even more than in use of the numerical flavor scores. Table 7 shows the standard errors of estimate (S_{YX}). However, the correlation coefficients (r) are generally highly significant.

An analysis of all three figures shows that when the oils were taken from storage, there was a significant decrease in the bland flavor and increases in the off flavors of grassy, tallowy, metallic, musty, painty, rancid, beany, and buttery flavors. However, after the 4-day heat treatment at 140° F., there was a significant improvement (increase) in the bland flavor, and varying decreases in grassy, tallowy, metallic, musty, painty, rancid, beany, and buttery flavors.

Nothing was done before the evaluations were made to define or interpret for panel members the meaning of the flavor descriptions used in the study. Accordingly, a panel more experienced in judging salad oils could have used the flavor descriptions differently and probably more in keeping with natural flavors of cottonseed oil.

However, it can be concluded that off flavors did develop during the unrefrigerated storage of the oils in sealed containers and that the 4-day heat treatment did remove part of these off flavors.

TABLE 5.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated immediately after removal from storage*

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 6 months at:												
0° F.:												
Source 1	53	41	0	2	0	0	0	0	0	0	4	0
Source 2	14	22	16	2	0	3	2	2	9	7	16	7
Source 3	42	36	8	0	0	0	2	0	4	0	2	6
All sources	36	33	8	1	0	1	1	1	4	3	7	5
55° F.:												
Source 1	45	41	9	0	0	0	0	0	0	0	0	5
Source 2	35	22	9	4	0	0	0	0	4	4	9	13
Source 3	50	25	4	4	0	0	0	0	4	4	9	0
All sources	43	29	7	3	0	0	0	0	3	3	6	6
70° F.:												
Source 1	17	26	30	9	0	0	0	0	0	0	18	0
Source 2	38	48	5	0	0	0	0	0	5	0	4	0
Source 3	42	29	8	4	0	0	0	4	0	4	9	0
All sources	32	34	15	4	0	0	0	1	2	1	11	0
80° F.:												
Source 1	35	43	9	0	0	0	0	0	0	0	4	9
Source 2	23	15	8	8	0	0	0	0	23	4	7	12
Source 3	59	18	14	0	0	0	0	0	0	5	4	0
All sources	39	25	10	3	0	0	0	0	8	3	5	7
90° F.:												
Source 1	46	37	4	4	0	0	0	0	0	0	7	0
Source 2	16	4	16	0	0	4	0	0	12	0	24	24
Source 3	45	23	9	5	0	0	0	0	0	13	0	5
All sources	36	21	10	3	0	1	0	0	4	4	10	11
100° F.:												
Source 1	32	32	8	0	0	0	0	4	4	0	4	16
Source 2	23	19	19	8	0	0	0	4	0	8	4	15
Source 3	27	27	12	0	0	0	0	0	3	4	23	4
All sources	27	26	13	3	0	0	0	2	2	4	10	13
110° F.:[1]												
Source 1	32	11	18	0	0	0	0	0	0	4	24	11
Source 2	---	---	---	---	---	---	---	---	---	---	---	---
Source 3	23	27	12	0	0	0	0	0	12	3	19	4
All sources	28	19	15	0	0	0	0	0	6	2	23	7
Oil stored 12 months at:												
0° F.:												
Source 1	43	41	5	0	0	0	0	5	0	0	6	0
Source 2	40	28	6	4	4	2	0	0	2	4	10	0
Source 3	72	19	3	0	0	0	0	0	0	0	6	0
All sources	52	29	5	1	1	1	0	2	1	1	7	0
55° F.:												
Source 1	27	27	23	0	0	0	0	0	0	0	13	10
Source 2	47	39	4	6	0	0	0	0	4	0	0	0
Source 3	59	14	8	5	0	0	0	5	4	0	0	5
All sources	44	27	12	4	0	0	0	2	3	0	4	4
70° F.:												
Source 1	24	44	9	6	0	0	0	0	0	0	11	6
Source 2	12	32	20	4	0	0	0	4	0	0	16	12
Source 3	45	21	0	12	0	0	0	0	3	0	10	9
All sources	27	32	10	8	0	0	0	1	0	0	12	10

See footnotes at end of table.

TABLE 5.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated immediately after removal from storage*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 12 months at:												
80° F.:												
Source 1	39	29	14	4	0	0	0	4	4	0	6	0
Source 2	36	18	9	0	0	0	5	14	5	0	4	9
Source 3	45	32	16	0	0	0	0	0	0	0	7	0
All sources	40	26	13	1	0	0	2	6	3	0	6	3
90° F.:												
Source 1	17	17	23	3	0	0	3	3	0	7	17	10
Source 2	26	17	17	2	3	0	0	3	9	6	0	17
Source 3	19	47	13	6	0	0	0	0	0	9	3	3
All sources	21	27	18	4	1	0	1	2	3	7	8	8
100° F.:[2]												
Source 1	6	37	13	3	0	0	0	9	0	3	20	9
Source 2	24	28	7	3	0	0	0	3	3	0	22	10
Source 3	34	26	17	6	0	0	0	0	9	3	5	0
All sources	21	30	12	4	0	0	0	4	4	4	16	5
110° F.:[3]												
Source 1	12	31	12	9	0	0	6	3	0	0	11	16
Source 2	13	52	0	3	3	0	19	0	6	0	4	0
Source 3	39	17	8	8	0	8	0	0	6	0	8	6
All sources	21	33	7	7	1	3	8	1	4	0	8	7
Oil stored 18 months at:												
0° F.:												
Source 1	43	44	7	4	0	0	0	0	0	2	0	0
Source 2	33	40	9	5	0	0	0	2	0	0	4	7
Source 3	44	32	6	6	0	2	2	4	2	0	2	0
All sources	40	39	7	5	0	1	1	2	1	0	2	2
55° F.:												
Source 1	45	32	5	0	5	5	0	0	0	0	8	0
Source 2	26	26	17	10	0	0	0	4	0	0	4	13
Source 3	19	48	15	4	0	0	0	0	0	0	10	4
All sources	30	35	12	5	3	3	0	1	0	0	6	5
70° F.:												
Source 1	36	27	10	4	0	0	0	0	9	9	0	5
Source 2	12	24	8	0	0	0	4	24	0	4	16	8
Source 3	27	35	12	4	0	0	0	0	0	0	7	15
All sources	25	29	10	3	0	0	1	8	3	4	8	9
80° F.:												
Source 1	44	22	0	4	0	0	11	0	4	4	8	3
Source 2	12	23	8	0	0	0	0	15	8	0	26	8
Source 3	28	44	8	0	0	0	0	0	0	4	12	4
All sources	28	30	5	1	0	0	4	5	4	2	15	6
90° F.:												
Source 1	13	21	5	0	0	0	5	0	0	29	2	25
Source 2	27	12	4	4	0	0	0	15	15	8	3	12
Source 3	30	27	4	4	0	4	0	0	0	0	8	15
All sources	26	20	4	3	0	1	2	5	5	13	4	17
100° F.:												
Source 1	41	23	9	0	0	0	0	0	0	0	23	4
Source 2	12	15	15	0	0	4	4	8	8	4	15	15
Source 3	13	43	22	4	0	0	0	0	4	0	14	0
All sources	22	27	15	1	0	1	1	3	4	1	17	8
110° F.:												
Source 1	13	17	10	0	0	0	7	0	13	0	0	40
Source 2	13	29	3	3	0	10	0	0	13	0	26	3
Source 3	22	11	7	0	0	4	0	0	0	4	8	44
All sources	16	19	7	1	0	5	2	0	9	0	11	30

See footnotes at end of table.

TABLE 5.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated immediately after removal from storage*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 24 months at:												
0° F.:												
Source 1	50	33	6	2	4	0	0	0	0	4	1	0
Source 2	56	29	2	6	0	0	2	0	0	0	5	0
Source 3	48	24	19	2	0	0	0	2	0	0	5	0
All sources	51	29	9	3	1	0	1	1	0	1	4	0
55° F.:												
Source 1	15	15	15	0	0	0	12	12	0	4	15	12
Source 2	11	14	25	0	0	0	7	0	0	4	18	21
Source 3	20	24	8	4	0	0	0	4	8	4	12	16
All sources	15	18	16	1	0	0	6	5	3	4	15	17
70° F.:												
Source 1	39	27	15	0	0	0	10	0	3	0	0	6
Source 2	16	19	13	0	0	0	6	6	10	3	17	10
Source 3	28	32	8	0	0	4	0	4	12	0	8	4
All sources	28	26	12	0	0	1	5	3	8	1	8	8
80° F.:												
Source 1	3	17	0	0	0	0	7	21	10	21	8	13
Source 2	20	37	7	3	0	0	0	0	0	27	0	6
Source 3	33	11	19	11	0	0	0	0	4	0	7	15
All sources	19	22	9	5	0	0	2	7	5	16	5	10
90° F.:												
Source 1	33	26	19	4	0	4	0	0	4	6	0	4
Source 2	4	11	11	4	0	4	4	0	0	0	25	37
Source 3	6	16	16	4	0	0	6	0	0	6	15	31
All sources	14	18	15	4	0	3	3	0	1	4	13	25

[1] Oil sampled at 5 months instead of 6.

[2] Oil sampled at 9 months instead of 12.

[3] Oil sampled at 8 months instead of 12.

TABLE 6.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated after removal from storage and treatment for 4 days at 140° F.*

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 6 months at:												
0° F.:												
Source 1	31	40	9	2	1	0	1	1	1	5	5	4
Source 2	16	23	6	0	0	2	3	4	3	8	18	17
Source 3	43	34	5	5	1	1	0	0	0	1	5	5
All sources	30	32	7	2	1	1	1	1	1	5	9	10
55° F.:												
Source 1	29	37	17	1	1	0	0	0	0	0	7	8
Source 2	27	34	4	1	0	3	4	3	1	5	11	7
Source 3	36	43	4	1	0	0	3	0	1	4	5	3
All sources	31	38	8	1	0	1	2	1	1	3	8	6
70° F.:												
Source 1	31	42	8	0	0	0	0	0	3	4	7	5
Source 2	8	25	12	1	0	2	2	1	2	11	23	13
Source 3	50	33	1	1	0	0	0	0	3	1	3	8
All sources	30	33	7	1	0	1	1	0	2	5	11	9

TABLE 6.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated after removal from storage and treatment for 4 days at 140° F.*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 6 months at:												
80° F.:												
Source 1	45	21	18	3	0	0	0	0	3	0	6	4
Source 2	15	28	15	0	0	3	4	4	1	6	21	3
Source 3	55	26	7	0	0	0	0	0	3	0	5	4
All sources	38	25	13	1	0	1	1	1	2	2	11	5
90° F.:												
Source 1	33	34	20	1	0	1	0	0	0	3	4	4
Source 2	25	13	17	3	0	3	0	0	12	3	17	7
Source 3	43	17	12	7	3	5	1	0	3	0	4	5
All sources	34	22	16	4	0	2	0	0	5	3	8	6
100° F.:												
Source 1	23	34	18	3	0	2	0	3	2	1	7	7
Source 2	17	26	15	4	0	1	1	0	2	10	15	9
Source 3	42	31	3	3	1	0	0	1	1	3	5	10
All sources	27	30	12	3	0	1	0	2	3	4	9	9
110° F.:[1]												
Source 1	16	30	31	0	1	0	0	2	2	5	5	8
Source 2	---	---	---	---	---	---	---	---	---	---	---	---
Source 3	31	34	5	7	0	0	0	0	2	2	11	8
All sources	24	32	18	3	0	0	0	2	2	3	8	8
Oil stored 12 months at:												
0° F.:												
Source 1	34	28	22	0	0	0	1	0	0	1	13	1
Source 2	21	37	13	1	2	0	1	0	3	2	13	7
Source 3	50	29	9	2	1	0	0	1	1	0	7	0
All sources	35	31	15	1	1	0	1	0	1	1	11	3
55° F.:												
Source 1	20	27	22	0	0	1	0	4	5	10	5	6
Source 2	45	26	6	7	0	0	0	0	2	4	8	2
Source 3	33	26	19	0	0	3	0	2	0	3	11	3
All sources	33	26	16	2	0	1	0	2	2	6	8	3
70° F.:												
Source 1	31	43	17	1	0	0	0	0	2	1	3	2
Source 2	32	30	15	0	0	0	0	0	6	2	15	0
Source 3	29	25	14	5	0	3	2	2	6	7	4	3
All sources	31	33	15	2	0	1	1	1	5	3	7	1
80° F.:												
Source 1	34	19	26	3	0	0	0	4	3	3	1	7
Source 2	29	19	13	5	0	0	0	1	6	1	23	3
Source 3	44	31	7	0	0	0	1	2	2	1	11	1
All sources	36	23	15	3	0	0	0	2	3	2	12	4
90° F.:												
Source 1	34	23	15	6	0	3	0	0	0	3	12	4
Source 2	24	29	12	6	0	0	2	1	2	1	12	11
Source 3	48	27	4	2	0	0	0	4	6	1	7	1
All sources	35	26	10	5	0	1	1	2	3	2	10	5
100° F.:[2]												
Source 1	26	37	5	3	0	0	0	3	2	4	15	5
Source 2	32	32	10	0	0	0	3	1	4	0	11	7
Source 3	54	26	9	0	0	0	0	1	0	3	5	2
All sources	37	32	8	1	0	0	1	2	2	2	10	5

See footnotes at end of table.

TABLE 6.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated after removal from storage and treatment for 4 days at 140° F.*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 12 months at:												
110° F.:[3]												
Source 1	23	29	8	4	0	0	0	3	6	2	20	5
Source 2	31	29	10	2	1	0	2	4	7	1	6	7
Source 3	42	36	5	1	0	0	0	1	0	0	15	0
All sources	32	31	8	2	0	0	1	3	4	1	14	4
Oil stored 18 months at:												
0° F.:												
Source 1	31	37	20	2	1	0	0	2	1	2	5	1
Source 2	11	27	17	0	0	1	1	1	3	7	19	13
Source 3	14	22	18	3	1	0	3	7	6	3	15	8
All sources	19	29	18	2	0	0	2	3	3	4	13	6
55° F.:												
Source 1	35	33	16	3	0	0	1	0	1	1	0	10
Source 2	16	29	6	1	0	1	4	8	6	5	5	19
Source 3	24	42	9	0	0	0	0	8	1	3	10	3
All sources	25	35	10	1	0	0	2	5	3	3	8	8
70° F.:												
Source 1	33	44	13	1	0	0	1	0	0	0	7	0
Source 2	19	52	10	0	0	0	1	2	4	4	6	2
Source 3	23	21	10	3	0	2	0	17	3	6	0	15
All sources	25	39	11	1	0	1	1	6	2	3	4	7
80° F.:												
Source 1	39	30	14	1	0	0	2	0	1	1	5	7
Source 2	12	21	8	0	0	2	3	11	11	7	13	12
Source 3	13	17	10	1	0	1	1	13	5	7	9	23
All sources	21	23	11	1	0	1	2	8	6	5	9	13
90° F.:												
Source 1	34	29	17	0	0	0	0	0	3	2	13	2
Source 2	25	29	12	1	0	1	2	13	2	3	5	7
Source 3	17	14	1	0	0	0	6	14	4	16	13	15
All sources	25	24	10	0	0	0	3	9	3	7	10	9
100° F.:												
Source 1	25	36	14	3	0	1	5	1	1	1	4	9
Source 2	15	26	17	1	0	3	1	4	3	1	22	7
Source 3	30	30	21	1	0	0	0	7	0	2	7	2
All sources	23	31	17	2	0	1	2	4	1	1	11	7
110° F.:												
Source 1	16	27	22	0	0	2	1	5	4	3	8	12
Source 2	13	33	10	1	0	0	7	3	0	2	26	5
Source 3	25	25	11	1	0	0	6	5	5	1	10	11
All sources	18	28	14	2	0	1	5	4	3	2	15	8
Oil stored 24 months at:												
0° F.:												
Source 1	19	29	12	2	0	0	9	7	0	0	15	7
Source 2	19	46	16	0	0	0	5	4	0	3	5	2
Source 3	23	42	10	2	0	0	2	2	2	6	7	4
All sources	20	39	13	1	0	0	5	4	1	3	9	5

See footnotes at end of table.

TABLE 6.—*Percent of panelists applying given adjectives to 3 cottonseed salad oils stored in 1-gallon sealed cans at 7 temperatures for specified times and evaluated after removal from storage and treatment for 4 days at 140° F.*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oil stored 24 months at:												
55° F.:												
Source 1	37	41	0	4	0	0	0	0	4	0	14	0
Source 2	28	31	3	0	0	0	10	6	0	3	6	13
Source 3	39	23	4	4	0	0	8	10	4	0	4	4
All sources	35	32	3	2	0	0	6	5	1	2	8	6
70° F.:												
Source 1	27	46	12	0	3	0	8	0	4	0	0	11
Source 2	16	19	10	0	0	0	0	3	0	16	17	19
Source 3	36	29	4	0	0	0	0	0	0	4	9	18
All sources	26	31	8	0	0	0	3	0	0	7	9	16
80° F.:												
Source 1	7	41	11	0	0	0	15	7	0	0	10	11
Source 2	21	21	17	0	0	0	3	0	0	3	18	17
Source 3	25	19	19	0	0	0	0	0	0	0	15	22
All sources	18	27	16	0	0	0	6	2	0	0	14	17
90° F.:												
Source 1	36	40	8	0	0	0	0	0	0	8	4	4
Source 2	19	19	0	0	0	11	3	0	11	6	31	11
Source 3	29	25	4	0	0	0	4	4	0	7	13	14
All sources	28	28	4	0	0	3	1	0	4	7	15	10

[1] Oil sampled at 5 months instead of 6.

[2] Oil sampled at 9 months instead of 12.

[3] Oil sampled at 8 months instead of 12.

TABLE 7.—*Correlation data for differences between percent of panelists applying given adjectives to 3 cottonseed salad oils after storage at 0° F. and percent of same panelists applying same adjectives to same oils after storage at 6 different temperatures, calculated before and after 4-day heat treatment of oils at 140° F.*

Flavor descriptive adjective[1] and heat treatment	Formula	N[2]	r[3]	S_{Y_X}[4]
Bland:				
Before heat treatment	$Y=-1.8702-1.1063X$	65	−0. 4292	±15. 5094
After heat treatment	$Y=-3.5673+0.4092X$	65	+0. 2881	±9. 0602
Buttery:				
Before heat treatment	$Y=-2.5971-0.2979X$	65	−0. 1536	±12. 7696
After heat treatment	$Y=+1.4846-0.2829X$	65	−0. 1701	±10. 9180
Beany:				
Before heat treatment	$Y=+5.5077-0.0959X$	65	−0. 0770	±8. 2774
After heat treatment	$Y=+5.9016-0.5574X$	65	−0. 4911	±6. 5874
Grassy:				
Before heat treatment	$Y=-1.4728+0.1871X$	65	+0. 0987	±2. 5628
After heat treatment	$Y=-0.2894+0.0218X$	65	+0. 0577	±2. 5175
Rancid:				
Before heat treatment	$Y=-0.3698+0.5998X$	65	+0. 3864	±9. 5393
After heat treatment	$Y=-4.1820+0.4353X$	65	+0. 4307	±6. 1134
Painty:				
Before heat treatment	$Y=-0.8367+0.1581X$	65	+0. 1954	±5. 2858
After heat treatment	$Y=+0.0717-0.0408X$	65	−0. 0082	+3. 7210
Metallic:				
Before heat treatment	$Y=-1.2346+0.2056X$	65	+0. 2690	±5. 9768
After heat treatment	$Y=-0.2617+0.0408X$	65	+0. 0724	±3. 7440

See footnotes at end of table.

TABLE 7.—*Correlation data for differences between percent of panelists applying given adjectives to 3 cottonseed salad oils after storage at 0° F. and percent of same panelists applying same adjectives to same oils after storage at 6 different temperatures, calculated before and after 4-day heat treatment of oils at 140° F.*—Continued

Flavor descriptive adjective [1] and heat treatment	Formula	N [2]	r [3]	S_{Y_X} [4]
Musty:				
Before heat treatment	$Y=-0.9847+0.2183X$	65	+0. 2907	±4. 7866
After heat treatment	$Y=+1.7020-0.0514X$	65	−0. 1133	±9. 4990
Tallowy:				
Before heat treatment	$Y=+0.5542+0.3043X$	65	+0. 2335	±8. 4404
After heat treatment	$Y=-0.3282-0.0382X$	65	−0. 0375	±6. 7796

[1] The flavor descriptive adjectives "sweet," "sour," and "bitter" were so seldom used that they are not considered here.

[2] Number of observations.

[3] Correlation coefficient. When N=65, then r=+0.244 at the 5-percent confidence limit, and r=+0.316 at the 1-percent confidence limit.

[4] Standard error of estimate.

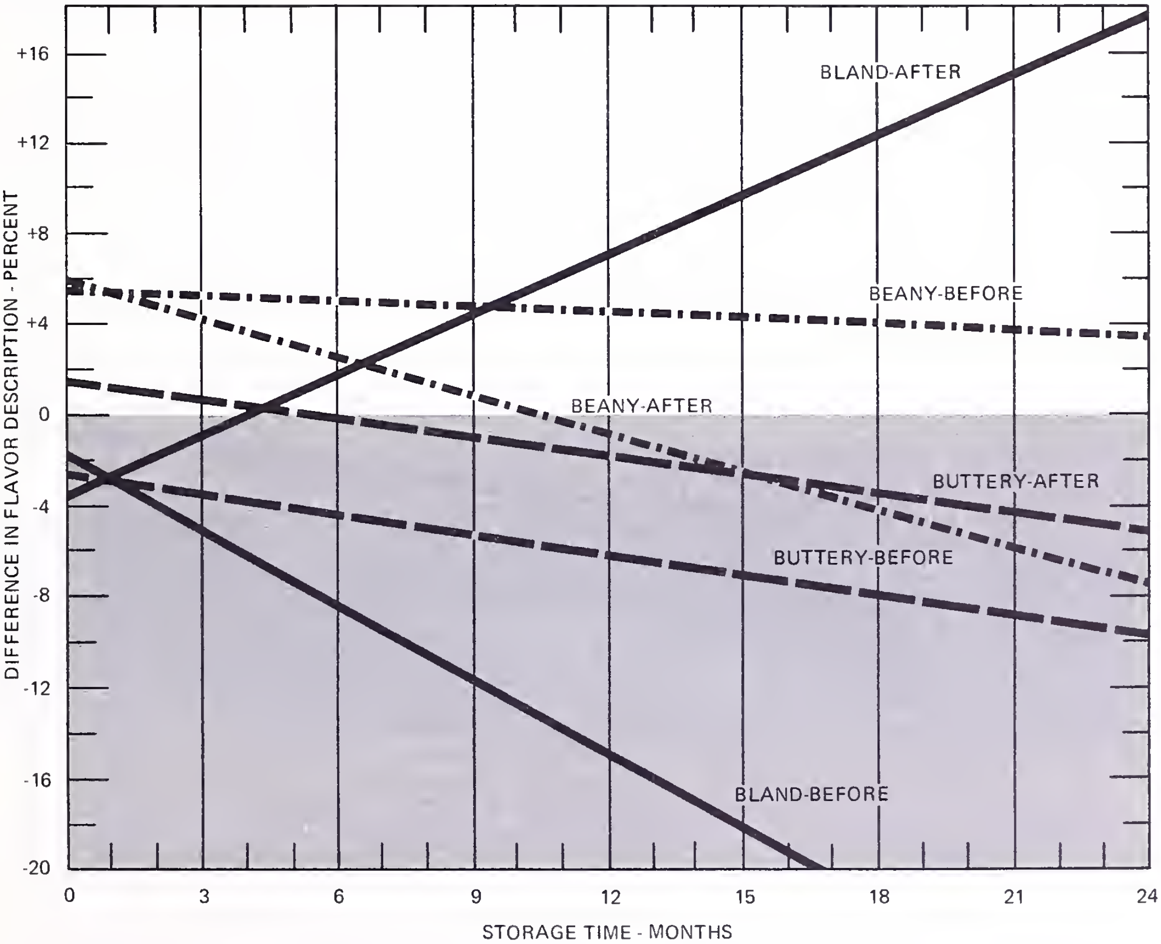

FIGURE 9.—Difference between incidence of bland, buttery, and beany flavors in cottonseed salad oils stored at 6 temperatures and incidence of same flavors in oils stored at 0° F., calculated before and after 4-day heat treatment at 140° F.

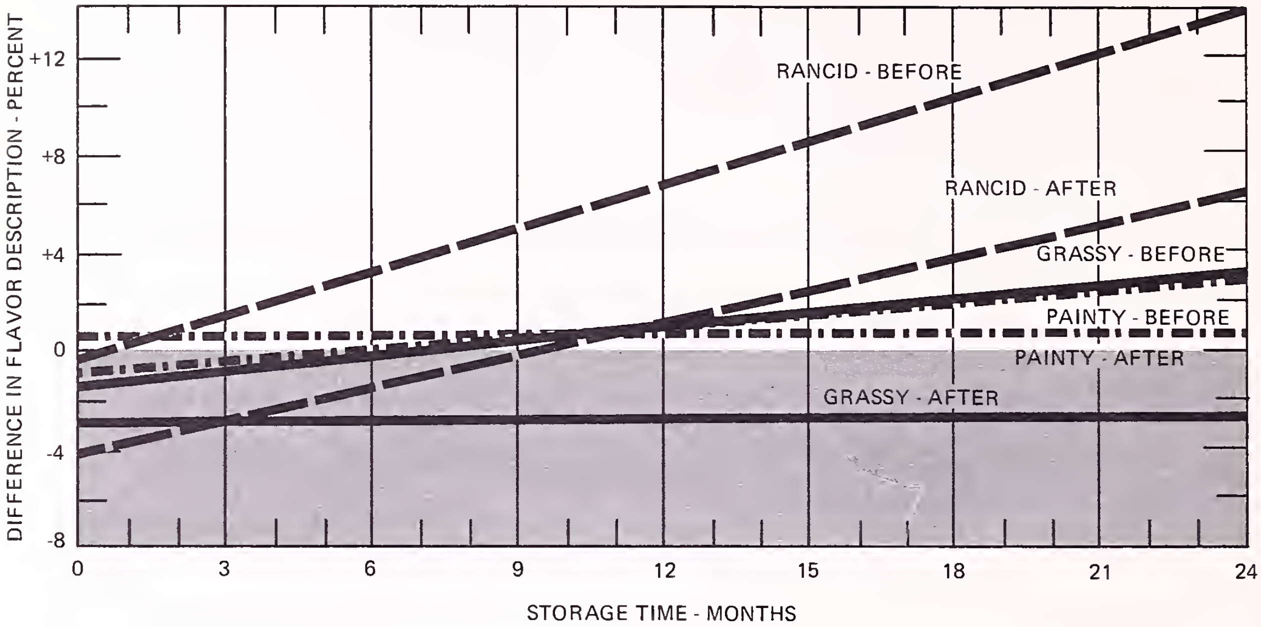

FIGURE 10.—Difference between incidence of grassy, rancid, and painty flavors in cottonseed salad oils stored at 6 temperatures and incidence of same flavors in oils stored at 0° F., calculated before and after 4-day heat treatment at 140° F.

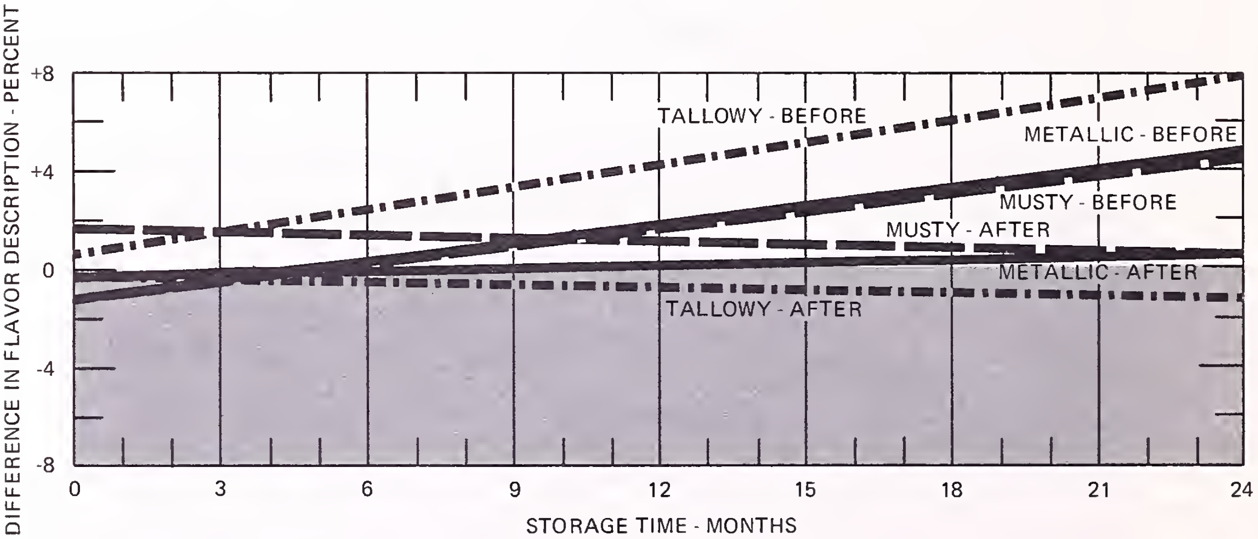

FIGURE 11.—Difference between incidence of tallowy, metallic, and musty flavors in cottonseed salad oils stored at 6 temperatures and incidence of same flavors in oils stored at 0° F., calculated before and after 4-day heat treatment at 140° F.

APPENDIX

Report 1

0-Time Flavor Panel Evaluation

Series______________ Source of Oil_________________

NAME OF PANELIST__________________________ Date__________________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F).

Determine intensity of odors first. Then taste for flavor beginning with oil of least odor followed by other oils of increasing intensity of odor.

*Code No.									
		Sample 1		Sample 2		Sample 3		Sample 4	
		O	F	O	F	O	F	O	F
Very Good	10								
Good	9								
	8								
Fair	7								
	6								
Poor	5								
	4								
Bad	3								
	2								
Very Bad	1								

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong

	Sample 1	Sample 2	Sample 3	Sample 4
Bland				
Buttery				
Beany				
Grassy				
Rancid				
Painty				
Metallic				
Musty				
Bitter				
Sour				
Sweet				
Tallowy				

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

Report 2

MQRD-ARS-USDA 2-106

4 Days at 60°C. Flavor Panel Evaluation

Series __________ Source of Oil ____________

NAME OF PANELIST __________________________ DATE ____________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F). Determine which oil has the less odor first. Taste this oil for flavor first.

*CODE NO.					
		SAMPLE 1		SAMPLE 2	
		O	F	O	F
Very Good	10				
Good	9				
	8				
Fair	7				
	6				
Poor	5				
	4				
Bad	3				
	2				
Very Bad	1				

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong.

	SAMPLE 1	SAMPLE 2
Bland		
Buttery		
Beany		
Grassy		
Rancid		
Painty		
Metallic		
Musty		
Bitter		
Sour		
Sweet		
Tallowy		

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

Report 3

0-Time Flavor Panel Evaluation

Series______________ Source of Oil____________

NAME OF PANELIST________________________ Date____________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F).

Determine intensity of odors first. Then taste for flavor beginning with oil of least odor followed by other oils of increasing intensity of odors.

*Code No.							
		Sample 1		Sample 2		Sample 3	
		O	F	O	F	O	F
Very Good	10						
Good	9						
	8						
Fair	7						
	6						
Poor	5						
	4						
Bad	3						
	2						
Very Bad	1						

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong

	Sample 1	Sample 2	Sample 3
Bland			
Buttery			
Beany			
Grassy			
Rancid			
Painty			
Metallic			
Musty			
Bitter			
Sour			
Sweet			
Tallowy			

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

Report 4

4-Day Flavor Panel Evaluation

Series________________ Source of Oil____________________

NAME OF PANELIST______________________ Date______________________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F).

Determine intensity of odors first. Then taste for flavor beginning with oil of least odor followed by other oils of increasing intensity of odors.

*Code No.							
		Sample 1		Sample 2		Sample 3	
		O	F	O	F	O	F
Very Good	10						
Good	9						
	8						
Fair	7						
	6						
Poor	5						
	4						
Bad	3						
	2						
Very Bad	1						

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong.

	Sample 1	Sample 2	Sample 3
Bland			
Buttery			
Beany			
Grassy			
Rancid			
Painty			
Metallic			
Musty			
Bitter			
Sour			
Sweet			
Tallowy			

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

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